The Derivatives Trader's Dilemma: How to Avoid Ruin as a Result of Stochastic Risk

An Honors Thesis (HONRS 499)

By

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Luck's a chance, but trouble's sure
I'd face it as a wise man would,
And train for ill and not for good.

A.E. Houseman
An excerpt from *Terence, This is Stupid Stuff*

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Abstract

Managing risk is a central concern for every derivatives portfolio manager, as failure to do so often initiates a path that leads to the destruction of the trader's capital. A particular type of risk—stochastic—is of special importance for this investment genre because it is magnified by the use of leverage in these markets.

Stochastic risk is the possibility of experiencing a string of unsuccessful trades imbedded in a longer and otherwise successful stream that will completely deplete the capital. The underlying assumption being that the portfolio manager is pursuing a trading strategy with a positive expected value. The market will not long support the manager who is following an unsuccessful strategy.

Though probability theory is an obvious place to look for methods of understanding and offsetting this risk, in reality it offers limited assistance. To overcome its shortcomings, a Monte Carlo simulation model will be developed to measure the magnitude of negative trade intervals, or drawdowns, so that adequate capital can be set aside in order to withstand these periods. An arbitrary payoff scheme will be used to demonstrate the model over a period of 500,000 trades.

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Introduction

Every investor, speculator and gambler faces the risk of ruin. The goal of this investigation is to provide derivatives traders with a tool that will enable them to avoid ruin as a result of stochastic risk.

To avoid ruin, it is important to understand both the process through which it is achieved and its catalysts, which include concentration, political, liquidity, economic, market and stochastic risk. Of these, stochastic risk is the most significant for derivatives traders due to the extensive use of leverage in these markets. Leverage magnifies both profits and losses, with fewer losses in succession being required for ruin.

The recent lifting of the ban on single stock futures, a derivatives instrument aimed not only at established derivatives traders but traditional equities investors as well, will make stochastic risk an issue of paramount concern to an entirely new group of investors otherwise unfamiliar with the unique risks associated with derivatives trading. To emphasize the importance of adjusting for stochastic risk when investing in derivatives, three disasters faced by prominent figures in this market will be highlighted.

The goal of this paper is to enable derivatives traders to circumvent ruin from stochastic risk; therefore, its uniqueness must be clearly understood. Stochastic risk is such that traders, whose buy/sell decisions are based on strategies with positive expected values for any trade, will experience a string of losses with insufficient capital in reserve to sustain them. The trader is thereby ruined, as they are prohibited from further trading.

The next logical step in the effort to prevent ruin is to determine the likelihood of its occurrence. Therefore, probability theory addressing methods for evaluating the risk of ruin will be briefly examined along with its shortcomings.

A Monte Carlo model, which overcomes the limitations of probability theory, will then be created. This model is designed to evaluate trading in a single market, and requires traders to have previously determined the performance expectations of their strategies.

The purpose of the model is to allow traders to ascertain the amount of capital they must hold in reserve while trading their systems to avoid ruin from stochastic risk. A simulation using arbitrarily determined performance expectations will be run, and its results examined to see how they would apply to a hypothetical trader.

Risk of Ruin: What is it?

No investor enters into a transaction anticipating a loss—if this were so, the venture would simply be avoided. However, the astute investors understand that losses must be the expected result of any fraction of their investment portfolios. It is when these losses go unchecked, are sequential and/or are significantly large that investors face the risk of ruin.

In essence, the risk of ruin is the probability that once an investment is made, a chain of events will be unleashed that consume the trader's capital base and eliminate any possibility of recovery. Traders can be certain they have experienced ruin if the results of their trading activity fit the mathematical definition:

$$\Sigma\text{-}(t_i,\ldots.t_j) \geq K$$

where t equals the gain or loss from an individual trade and K equals the capital available for trading. In this situation, the net result of a series of trades is negative in an amount equal to or greater than the trader's capital, who is thereby devastated. The greatest expense of this outcome is not the monetary loss, but the loss of the ability to continue trading.

Derivatives

Because this paper is concerned specifically with the problems of derivatives traders—particularly those involved in the commodities market—it is important to understand the instruments with which they deal.

Derivatives market instruments "derive" their existence from some underlying asset, index or spot market (Melloan, 1995) and include commodities, stock options and the soon-to-be-created single stock futures. Commodities contracts allow investors to speculate about future price movements through the buying and selling of contracts for goods that will be delivered at some future specified date. However, traders do not have to hold the contract until that date, as they may exit an open trade at any time by completing the opposite side of the transaction (what they bought, they must sell and vice versa).

The commodities market offers investors a unique opportunity to use leverage to their benefit. Because margin requirements on commodities are small, typically running at or below 5 percent, it is possible for traders to receive significant returns on small investments. However, minimal margin requirements also make investors much more vulnerable to negative price movements, thus magnifying their losses.

It is this ability to use leverage extensively that makes stochastic risk such an important issue for derivatives traders in the commodities market. Fewer losses are required in succession to deplete their capital when these losses are large.

Single Stock Futures

As mentioned earlier, single stock futures are the newest type of derivative instrument to hit the market. They are a hybrid investment and possess characteristics of both stock

options and commodities contracts. Like options, single stock futures are pegged to a company's shares, but instead of simply conveying the right to purchase or sell a stock, they will be settled at a predetermined delivery date by cash or delivery of shares, similar to commodity contracts. (McKay, 2001)

Single stock futures are geared toward both established derivatives traders and traditional equities investors otherwise unfamiliar with the unique hazards associated with investing in derivatives. (Jenkins, 2001) Whereas the stochastic risk associated with holding a portfolio of securities in the equities market is low, the flow of gains and losses in derivatives markets is magnified by leveraged trading. Therefore, stochastic risk will become relevant to an entirely new group of investors.

Derivatives Disasters

In order to emphasize the importance of making appropriate adjustments for stochastic risk in the derivatives market, three disasters that resulted from a failure to do just this will be discussed.

Victor Niederhoffer

In his heyday, Victor Niederhoffer, the contrarian speculator famous for his unconventional methods that included trading barefoot and shunning all newspapers except the *National Enquirer*, managed three private hedge funds (Colarusso, 1997) which, at their peak, were valued at $130 million. (Jereski, 1997) Then, in the summer of 1997, Niederhoffer's funds suffered a series of extremely large stochastic losses that devastated their capital.

The first of these losses took place in the Thai stock market, which had begun a downward spiral some time before Niederhoffer decided to enter. (Jereski, 1997) Then, in the summer of 1997, Thailand's currency, the baht, collapsed, causing the depressed stock market to plunge even further, leaving Niederhoffer with a $50 million dollar loss. (Colarusso, 1997)

Though a little worse for the wear, the funds were not finished. Niederhoffer's next move was to go long on the S & P 500 by writing puts during a moment of market weakness in anticipation of an upswing. This turnaround never materialized, and as the market continued its decent, both Niederhoffer and his funds were wiped out. (Colarusso, 1997)

Even after he had experienced financial ruin, Niederhoffer believed his strategy was correct. (Fabrikant, 1998) The accuracy of his belief is not the question of this paper; however, it does demonstrate that believing a strategy to have a positive expected value is not sufficient protection against stochastic risk.

Nick Leeson and Barings Bank

The demise of Barings PLC, a 223-year-old British investment bank, as the result of $1.24 billion in derivatives losses can be attributed to an inability to react appropriately to stochastic risk.

In the early 1990s, Nicholas Leeson, a settlements specialist, was sent to the Singapore office of Barings' international equities arm to straighten out some clerical issues. Within a year, Leeson had joined the Barings trading team on the floor of the Singapore International Monetary Exchange (Simex) where his primary responsibility was to arbitrage Nikkei futures contracts. Soon thereafter, Leeson was named chief trader in addition to his settlement duties, essentially leaving him to regulate himself. (Mark, 1995)

Unfortunately, this lack of supervision did not go unnoticed, and Leeson began taking unauthorized long positions on behalf of Barings under fictitious client accounts (Barings did not allow proprietary trading). This left the company exposed to huge losses if the Tokyo market fell, which it did when an earthquake struck Kobe, Japan, in January 1995. (Mark, 1995)

Prior to this event, Leeson's illicit trading activity had worked brilliantly, increasing his office's profits from $1.6 million in the year before he arrived to $30 million in the first seven months of 1996. (Brauchli, 1995) However, when the market fell and Leeson's long positions went bad, rather than cut his losses by closing out his positions, he doubled them in an effort to support the market. Unfortunately, his attempt to fight the market and stochastic risk not only devastated him personally, but also ruined Barings. (Mark, 1995)

As a result of this fiasco, Lloyd's of London now offers rogue trader insurance. (lloydsoflondon.com)

Long-Term Capital Management

The collapse of Long-Term Capital Management LP, the hedge fund founded by John W. Meriwether and partners that included Nobel Prize-winning economists Robert Merton and Myron Scholes, was a product of many types of risk. It was stochastic risk, however, that got the ball rolling. (Lenzner, 1998)

Long-Term Capital Management's trading strategy was based on models designed to predict how various markets would act and react in essentially normal times. (Lipin, 1998) Rather than betting on the direction in which the market would move, the group made bets on

the relationships between securities, believing that discrepancies between similar instruments would narrow. (Lenzner, 1998)

Unfortunately for Long-Term Capital, a worldwide financial crisis arose when the Russian financial system collapsed in 1998. This event created chaos in the markets and caused market spreads to widen instead of contract as forecasted by their predictions. Many of Long-Term Capital's positions went bad almost simultaneously and they piled up enormous losses. (Raghavan, 1998)

Despite the fact that Long-Term Capital had routinely racked up annual gains of more than 50 percent, (Raghavan, 1998) the firm was not prepared to sustain a major series of losses, and the firm succumbed to ruin. (Lipin, 1998)

Stochastic Risk

Only the most blindly optimistic individual can believe they will never experience a severe losing streak. The key to surviving such an event is to have a cash reserve large enough to cover the losses, thereby protecting the trader from ruin.

The first step toward avoiding ruin from stochastic risk is to clearly define the enemy. To do this, it is necessary to understand the nature of a stochastic process, which the *Random House Colligate Dictionary, Revised Edition*, defines as one that

> "pertains to a process involving a randomly determined sequence of observations, each of which is considered as sample of one element from a probability distribution. Stochastic variation implies randomness as opposed to a fixed rule or relation in passing from one observation to the next in order."

A simple example of the stochastic process is the flipping of a coin. Each flip results in either heads or tails, but the outcome of each flip is completely unrelated to those that proceeded it and those that follow. Though it is understood that in the long run the number of

heads will approximately equal the number of tails, the experiment could at times yield a long, unbroken chain of either heads or tails.

This is relevant to derivatives traders in comparing a series of flips to a series of trades. Though their trading systems might indicate a certain ratio of successful trades to unsuccessful ones, traders could at any time experience a long series of either wins or losses. Stochastic risk, then, is the risk of experiencing a string of losing trades without enough cash in reserve to sustain the losses. Traders are thereby ruined, as they are prevented from continuing to trade until a profitable sequence can be reached.

Probability Theory

The next logical step in the effort to avoid ruin is to determine the likelihood that ruin will be achieved. Probability theory offers a few alternatives that may be used to calculate risk of ruin, but they are limited in their usefulness. A more widely applicable simulation to evaluate this risk will be developed and discussed later.

One alternative for calculating the risk of ruin is the following formula developed by William Feller for use in the simple two opponent game:

$$R = \{(q / p)^a - (q / p)^k\} / \{(q / p)^a - 1\}$$

where R equals the risk of ruin, the trader has k units of capital, their opponent has $(a - k)$ units of capital where a equals overall market capitalization, the probability of success is given by p, and the complementary probability of failure is given by q, where $q = (1 - p)$. (Feller, 1950)

This formula for computing the risk of ruin makes two simplifying assumptions:

(1) the payoff ratio, or the ratio of the average trade win to the average trade loss, is one

(2) the investor's entire amount of capital is risked to trading. (Feller, 1950)

Balsara Nauzer extends Feller's discussion of this formula to the market in *Money Management Strategies for Futures Traders* and concludes that because the probability of winning, p, exceeds the probability of losing, q, the fraction (q / p) is less than one. Also, since the trader's opponent can be assumed to be the market as a whole, the overall market capitalization, a, is large as compared to k, and for practical purposes the term $(q / p)^a$ tends to zero, reducing the probability of ruin to

$$(q / p)^k.$$

In this formula, the risk of ruin is a function of

(a) The probability of success;

(b) The number of units of capital available for trading.

Therefore, the greater the probability of success, the lower the risk of ruin. Additionally, the smaller the fraction of capital exposed to trading, the smaller the risk of ruin for a given probability of success. (Nauzer, 1992)

An alternative to this formula for determining the probability of ruin is presented by Richard J. Teweles and Frank J. Jones in their book *The Futures Game*. Their formula, which produces the same result as Nauzer's formula, is

$$R = (1- a / 1 + a)^c$$

where a is the traders' advantage expressed in decimal form, and c is the number of trading units with which they begin. If a trader's probability of success is 0.65 and his probability of

failure is 0.35, his advantage is 0.20, and if a trader has capital of $10,000 and is willing to risk $1,000 per trade, he has 10 trading units. (Teweles, 1998)

However, all of these formulas are limited to situations in which the payoff ratio, or the average win to the average loss, is one. If the ratio is greater than one or is unequal, the equations associated with risk of ruin calculations do no lend themselves to a precise or closed-form solution. The next best alternative is to simulate the probability of ruin. (Nauzer, 1992) In his book, *Quantative Trading and Money Management: A Guide to Risk Analysis*, Fred Gehm suggests that "there is almost certainly no closed formula for calculating the risk of ruin when wins and losses are variables. This means that *R* will have to be found by brute force, by a Monte Carlo simulation." (Gehm, 1995)

The Monte Carlo model developed for this paper does not specifically calculate the risk of ruin in the fashion suggested by Gehm. Instead, it will answer the question of how much capital the derivatives portfolio manager needs to avoid ruin from stochastic risk while pursuing a particular trading strategy.

The Monte Carlo Model

The use of the Monte Carlo simulation allows the trader utilizing a system with variable outcomes to more accurately and efficiently calculate their risk.

A Monte Carlo simulation can be described as an exaggerated coin flipping operation, where *t* represents a single flip for which there exists both the probability of success (for example, a head) and the probability of failure (a tail), and the interval $(t_i \ldots . t_j)$ represents a series of unrelated flips. This is a stochastic process.

The model created for this paper is intended for use by derivatives traders working in the commodities markets.[1] It is a simple single market model, intended to evaluate trading in only one commodity. Therefore, no systemic risk exists as there are no correlations between markets to be considered. In addition, the model assumes that only one contract will be traded at a time, and that reserve capital is not invested elsewhere.

The trader's capital, *K*, is composed of two elements: *M*, the margin required by the exchange to purchase a contract in the particular commodity the trader is interested in, and *R*, the reserve capital that will not be exposed to trading, or

$$K = (M + R).$$

The aim of this model is to enable traders to determine how large *R* should be in order to avoid ruin. The level of reserve determined by this simulation must be sufficient to accommodate the flow of gains and losses into and out of the portfolio resulting from stochastic risk. For the purposes of this model, other types of risk, such as concentration, political, liquidity, economic and market, have been held constant.

It is important to remember that in probability theory, *K*, or capital, has always been assumed to be a constant. This model reverses that question by making capital a variable and asking how large *K* should be to fit traders' performance expectations as determined by their strategies. Naturally, these expectations will vary from trader to trader, and the purpose of this model is neither to determine nor dictate them. The model simply advises the trader, given his expectations, how much capital he should possess to trade his strategy and how much of that should be held in reserve.

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[1] * A Monte Carlo model has been constructed using Microsoft's Excel spreadsheet. The model, stored under the file name Monte Carlo Simulator, is attached. The file has been compressed in MC Simulator.zip.

Simulation

If traders' performance expectations are known—the expected distribution of successes and failures and the corresponding payoffs—it is then possible to construct the payoff matrix. The payoff matrix used for this simulation is a simple three-outcome model that was determined arbitrarily. However, the matrix could be highly complex with multiple entries. For the purposes of this paper, the payoff matrix is defined as having a 45 percent chance of a profit of 1.5 units, a 45 percent chance of a loss of –1 units, and a 10 percent chance of neither a profit or a loss (see Table 1).

Table 1

Monte Carlo Simulator

Payoff Matrix

Distribution	Payoff
.000-.45	1.5
.450001-.90	-1
.900001-1.0	0

To begin the simulation, 500,000 mock trades were produced by a random number generator. This trade series was then divided into 500 sets of 1,000. Each individual trade was then linked to the payoff matrix to determine its value (see Table 2).

The focus of the model is not the outcome of any particular trade; it is the outcome of an interval of trades. This is because ruin is defined as an interval of trades that are negative in an amount greater than the trader's capital. For this reason, each 1,000-trade set

was summed on a rolling basis in groups ranging from 20 to 100 trades in order to determine the value of intervals of trades Table 2 illustrates how the intervals are summed over different trading periods.

Table 2

Monte Carlo Simulator

Set A:

Random Number	Trade Outcome	Total Profit/Loss for x trades... 20	40	60	80	100
0.340177	1.5	4	10	13.5	10.5	18.5
0.614943	-1	4	7.5	11	10.5	18.5
0.65124	-1	4	10	12	10.5	21
0.910127	0	4	10	12	13	23.5
0.82624	-1	5.5	9	11	14.5	22.5
0.535143	-1	8	9	11	17	22.5
0.349756	1.5	10.5	11.5	13.5	18	25
0.963217	0	8	11.5	11	18	25
0.471408	-1	9.5	10.5	12.5	17	24
0.541361	-1	10.5	13	12.5	17	25
0.990216	0	13	15.5	12.5	19.5	25
0.900246	0	14.5	14.5	14	18.5	24
0.364932	1.5	16	13.5	13	17.5	25.5
0.187672	1.5	16	13.5	10.5	15	25.5
0.83793	-1	13.5	13.5	10.5	15	23
0.099109	1.5	13.5	13.5	10.5	17.5	25.5
0.538081	-1	11	11	10.5	15	23
0.137907	1.5	13.5	11	10.5	16	23
0.389935	1.5	11	11	9	16	21.5
0.259362	1.5	8.5	9.5	6.5	16	21.5
0.226773	1.5	6	9.5	6.5	14.5	21.5
0.613041	-1	3.5	7	6.5	14.5	20
0.618315	-1	6	8	6.5	17	20
0.073464	1.5	6	8	9	19.5	20

The worst interval for each of the five categories was determined for each of the 500 sets. This information was compiled in 10-set groups to create 50 Summation Sheets. The letters A through J in the Summation Sheets each present the results of one 1,000-trade set. (see Table 3). The maximum loss was then selected for each set (see Table 3).

Table 3

Monte Carlo Simulator

Summation Sheet
Sample 1

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-12	-12.5	-9	-11.5	-15	-9	-9.5	-11.5	-13
Maximum Loss: 40 trades	-15.5	-12.5	-11	-5	-13.5	-16	-8.5	-8	-9	-10.5
Maximum Loss: 60 trades	-12	-10.5	-10	-3.5	-8	-12.5	-5.5	-11	-8	-10
Maximum Loss: 80 trades	-5	-10.5	-8.5	-4	-7	-17	-1	-11.5	0	-9
Maximum Loss: 100 trades	-6.5	-16.5	-7.5	-3	-3.5	-19	2	-2.5	5	-6.5
Maximum(Maximum x trades)	-15.5	-16.5	-12.1	-9	-13.5	-19	-9	-11.5	-11.5	-13

The Summary Sheet (Table 4) compiles the maximum loss results from all 50 Summary Sheets. Each row of ten sets is then examined to determine the minimum and maximum loss interval (see Table 4). Because the results of 500,000 trades are represented in these numbers, the experience of several lifetimes can then be analyzed.

Table 4

Monte Carlo Simulator

50 samples of 10-1000 trade trials

		A	B	C	D	E	F	G	H	I	J	Min	Max
Sample	1	-15.5	-16.5	-12.5	-9	-13.5	-19	-9	-11.5	-11.5	-13	-9	-19
	2	-17	-8	-11.5	-13	-13.5	-11	-9.5	-9	-10	-14	-8	-17
	3	-8.5	-10	-9.5	-17.5	-7	-12.5	-9	-16	-22	-14.5	-7	-22
	4	-9	-9.5	-14	-11.5	-10	-7.5	-11.5	-12	-8.5	-17	-7.5	-17
	5	-17	-10.5	-16	-15.5	-7.5	-16.5	-17	-8	-8.5	-8	-7.5	-17
	6	-10.5	-9	-7	-10.5	-29	-11	-9.5	-13	-9	-14	-7	-29
	7	-13.5	-10	-10	-9	-15.5	-16	-9.5	-19	-14.5	-12.5	-9	-19
	8	-10.5	-9.5	-10.5	-7	-14	-12	-17	-5.5	-9.5	-10	-5.5	-17
	9	-19	-11.5	-11	-10	-8.5	-13	-9	-11	-11.5	-9	-8.5	-19
	10	-12.5	-16.5	-14	-10	-9.5	-6.5	-9	-10.5	-15	-8.5	-6.5	-16.5
	11	-19.5	-8	-11	-8.5	-10	-11.5	-18.5	-11.5	-17	-11	-8	-19.5
	12	-14.5	-9.5	-15	-13	-9.5	-13.5	-11.5	-9	-7	-16	-7	-16
	13	-11.5	-12.5	-10	-10	-12	-20	-18	-10.5	-13.5	-11	-10	-20
	14	-11.5	-16.5	-9.5	-9	-10	-11.5	-13	-13	-23.5	-8.5	-8.5	-23.5
	15	-21	-10	-11.5	-11.5	-18	-10.5	-8	-15.5	-19.5	-14.5	-8	-21
	16	-10	-15	-14.5	-11	-12	-14	-11.5	-21.5	-14	-11.5	-10	-21.5
	17	-7.5	-11	-14.5	-10.5	-9	-13	-11	-6.5	-14.5	-14	-6.5	-14.5
	18	-7	-12	-13.5	-8	-25.5	-21.5	-17	-6.5	-10.5	-14.5	-6.5	-25.5
	19	-7.5	-17	-14.5	-17.5	-11.5	-13	-14.5	-12	-15	-6.5	-6.5	-17.5
	20	-23	-14.5	-12.5	-10.5	-12	-16.5	-9	-8	-21	-8	-8	-23
	21	-16	-7.5	-9.5	-12.5	-13	-9	-15.5	-5.5	-11	-8	-5.5	-16
	22	-8	-8.5	-16	-11	-16	-12	-15	-8	-11.5	-10	-8	-16
	23	-11	-7.5	-20.5	-10	-14.5	-9	-10.5	-9	-11.5	-11.5	-7.5	-20.5
	24	-10.5	-15.5	-14.5	-11	-7	-9	-12.5	-12	-12	-13.5	-7	-15.5
	25	-11.5	-32.5	-13	-11.5	-15	-8	-8.5	-15	-19.5	-12.5	-8	-32.5
	26	-10.5	-12.5	-7.5	-7.5	-16	-12.5	-13.5	-16	-11.5	-10.5	-7.5	-16
	27	-14.5	-9.5	-15	-8	-10	-11.5	-25	-11.5	-11.5	-9.5	-8	-25
	28	-13	-13.5	-12	-15	-14.5	-7	-20	-17	-7	-8.5	-7	-20
	29	-12	-16	-7	-14	-15	-8.5	-9.5	-9.5	-14	-10	-7	-16
	30	-15	-9.5	-17.5	-14	-11.5	-16.5	-12	-8.5	-8	-12	-8	-17.5
	31	-6.5	-17	-8.5	-9	-9	-10	-9	-15	-8	-13	-6.5	-17
	32	-13	-12	-11.5	-9	-12.5	-9.5	-9.5	-11.5	-17	-12.5	-9	-17
	33	-8	-10.5	-15.5	-9	-14	-9	-10.5	-16.5	-21.5	-13.5	-8	-21.5
	34	-12	-8.5	-10.5	-13.5	-11	-9	-10	-9	-13	-9.5	-8.5	-13.5
	35	-13	-14.5	-10.5	-17	-14	-20	-9	-13.5	-13.5	-9	-9	-20
	36	-12	-11.5	-10.5	-17.5	-17.5	-17	-11.5	-11	-8	-9	-8	-17.5
	37	-11	-12.5	-10	-10.5	-9	-17	-11.5	-8	-10	-11	-8	-17
	38	-7	-7.5	-9.5	-21.5	-11.5	-13.5	-12.5	-10	-9.5	-12	-7	-21.5
	39	-13.5	-9.5	-9.5	-10.5	-10.5	-11.5	-14.5	-15	-11.5	-17	-9.5	-17
	40	-8	-7.5	-10	-16.5	-12	-9	-11.5	-9	-12.5	-10.5	-7.5	-16.5
	41	-13	-12	-14.5	-9.5	-23	-14	-10	-14	-9.5	-12	-9.5	-23
	42	-11.5	-12	-9.5	-6.5	-18.5	-12	-13	-14	-9	-15.5	-6.5	-18.5
	43	-14	-11	-10	-11	-7.5	-9	-12.5	-13	-11.5	-20	-7.5	-20
	44	-9	-22	-12	-9.5	-10.5	-12	-12.5	-11	-8	-13.5	-8	-22
	45	-8.5	-10.5	-18.5	-14.5	-10.5	-12	-14.5	-11.5	-9	-14.5	-8.5	-18.5
	46	-11.5	-12	-9	-10.5	-11	-11.5	-10.5	-11.5	-10	-12	-9	-12
	47	-10.5	-10.5	-8.5	-13.5	-13.5	-9.5	-20	-9.5	-8	-12	-8	-20
	48	-13	-10	-14	-18.5	-14.5	-10	-18	-10.5	-15.5	-16	-10	-18.5
	49	-14.5	-14	-13.5	-17	-15	-20	-9	-9	-5.5	-9	-5.5	-20
	50	-10	-17	-12.5	-12.5	-10.5	-15	-10.5	-10	-19.5	-7	-7	-19.5

Analysis

The results of this Monte Carlo simulation can now be evaluated and applied to a hypothetical trader. The total loss expected from the worst interval of x trades, known as drawdown, is identified by examining the minimum and maximum columns in Table 4. This loss is measured in units of one, where the actual monetary equivalent as is established by the trader. This unit of one is the amount of money the trader has established as the maximum loss allowed with his strategy.

The minimum drawdown experienced during the 500,000 simulated trades given the arbitrary payoff matrix defined in Table 1 was 5.5 units, while the maximum was 32.5 units. This means that a loss of 5.5 units **will** occur every 10,000 trades and a loss of 32.5 units **will** occur at some point in every interval of 500,000 trades. In order to survive this worst interval, the trader must have 32.5 units of capital in reserve, R, in addition to their trading capital, M.

To illustrate this conclusion, the hypothetical trader will be said to have defined the unit of 1 as $200. Therefore, to survive the worst interval of trades, the reserve capital, R, must equal $200 multiplied by 32.5 units of capital, or $6,500. If the margin was $500, or M, the strategy would require $7000 in trading capital to execute the strategy and avoid suffering ruin as a result of stochastic risk.

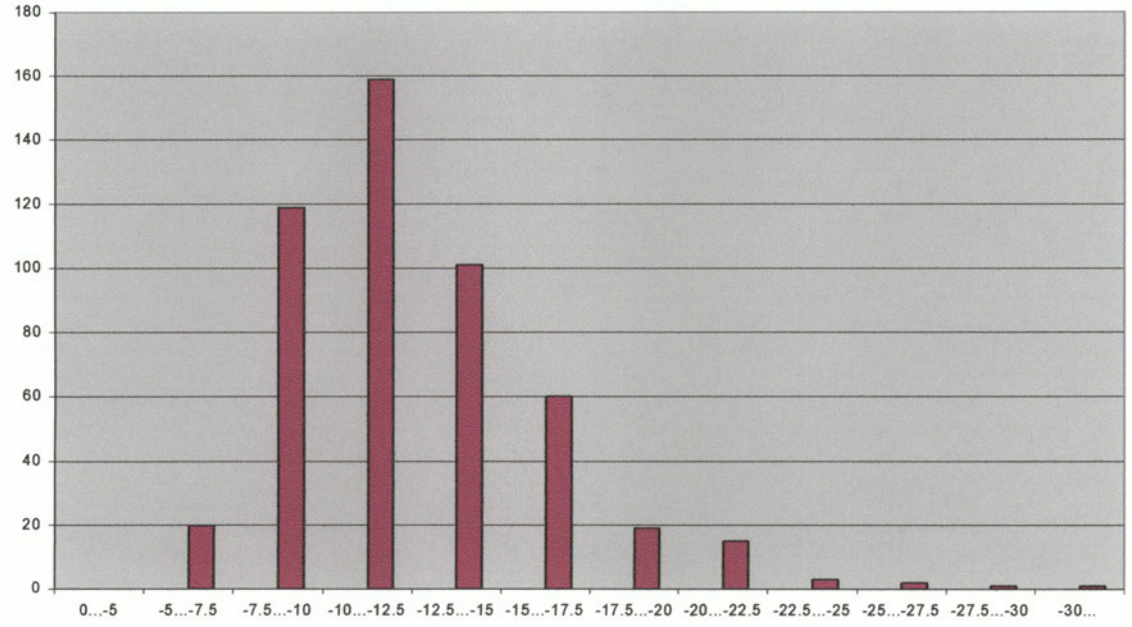
Graph 1, the "Drawdown Distribution," provides a visual summation of the data presented in Table 4. This graph describes the number of occurrences of a particular drawdown in intervals of –2.5 units. The mean of the drawdowns is –12.193, the mode is –11.5, and the median is –11.5.

The worst interval experienced over the course of the 500,000 trades is more than 2.5 times the average. The occurrence of losses greater than –20 units is rare, comprising only 4.4

percent of the sample, but their very presence clearly shows that these instances must be anticipated and prepared for if ruin is to be avoided.

The data generated by this simulation is unique to this particular payoff matrix. Each new matrix will generate a distinctive set of drawdowns.

was then selected



Conclusion

A Monte Carlo model can be an invaluable tool for derivatives traders wishing to elude ruin by stochastic risk, and can be developed quickly and easily using a spreadsheet program. The model can then simulate many years' worth of trading results quickly, thereby providing the trader with great volumes of experience. Traders can then examine this data to determine the frequency and magnitude of drawdowns they will experience in their actual trading. It is then possible to estimate the reserve capital necessary to weather the most negative interval of trades the strategy might encounter.

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Appendix

500,000 trades

Monte Carlo Simulator

Sample 1

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-12	-12.5	-9	-11.5	-15	-9	-9.5	-11.5	-13
Maximum Loss: 40 trades	-15.5	-12.5	-11	-5	-13.5	-16	-8.5	-8	-9	-10.5
Maximum Loss: 60 trades	-12	-10.5	-10	-3.5	-8	-12.5	-5.5	-11	-8	-10
Maximum Loss: 80 trades	-5	-10.5	-8.5	-4	-7	-17	-1	-11.5	0	-9
Maximum Loss: 100 trades	-6.5	-16.5	-7.5	-3	-3.5	-19	2	-2.5	5	-6.5
Maximum x trades	-15.5	-16.5	-12.5	-9	-13.5	-19	-9	-11.5	-11.5	-13

Monte Carlo Simulator

Sample 2

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-7	-11.5	-13	-8	-8.5	-9	-9	-10	-11.5
Maximum Loss: 40 trades	-12	-8	-8	-13	-9.5	-9	-9.5	-6.5	-6.5	-12
Maximum Loss: 60 trades	-17	-1.5	-5	-2.5	-10.5	-8.5	-7	-7	-4	-14
Maximum Loss: 80 trades	-13.5	1.5	0.5	-0.5	-13.5	-8.5	-3.5	-8	-2.5	-9.5
Maximum Loss: 100 trades	-8.5	8.5	0.5	2	-11	-11	-1	-3	-3	-9
Maximum x trades	-17	-8	-11.5	-13	-13.5	-11	-9.5	-9	-10	-14

Monte Carlo Simulator

Sample 3

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8.5	-9.5	-9.5	-12.5	-7	-9.5	-9	-11.5	-13	-11
Maximum Loss: 40 trades	-6.5	-10	-7.5	-13	-6.5	-10.5	-8.5	-8.5	-18	-14
Maximum Loss: 60 trades	-4	-7	-7	-17.5	-1	-12.5	-9	-16	-15.5	-14.5
Maximum Loss: 80 trades	-4	-7.5	-5	-14	0.5	-9	-6.5	-12.5	-19.5	-11
Maximum Loss: 100 trades	6.5	-3.5	-5.5	-11.5	5	-7	-7	-15.5	-22	-11
Maximum x trades	-8.5	-10	-9.5	-17.5	-7	-12.5	-9	-16	-22	-14.5

Monte Carlo Simulator

Sample 4

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-9	-8	-14	-11.5	-10	-7.5	-11.5	-9.5	-8.5	-11.5
Maximum Loss: 40 trades	-4.5	-9.5	-10.5	-8	-9	-6	-7	-9.5	-5	-14
Maximum Loss: 60 trades	-6.5	-5	-8.5	-5	-9.5	-7.5	-7	-12	-3	-17
Maximum Loss: 80 trades	3	-6	-7.5	-4.5	-8.5	-6	-6	-9.5	-1	-9
Maximum Loss: 100 trades	1.5	-1	-4.5	-1	-1	-1.5	-5.5	-11.5	4	-9.5
Maximum x trades	-9	-9.5	-14	-11.5	-10	-7.5	-11.5	-12	-8.5	-17

Monte Carlo Simulator

Sample 5

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8	-10.5	-14	-10	-7.5	-12	-12.5	-6.5	-8.5	-8
Maximum Loss: 40 trades	-11	-6	-16	-11.5	-4.5	-14.5	-17	-8	-3.5	-7
Maximum Loss: 60 trades	-12.5	-6.5	-13	-15.5	0.5	-16.5	-13.5	-3.5	-0.5	-2.5
Maximum Loss: 80 trades	-13	3.5	-8	-12.5	5.5	-13.5	-11	1	7	-3
Maximum Loss: 100 trades	-17	3.5	-7.5	-10	8.5	-10.5	-8	5	11.5	-2
Maximum x trades	-17	-10.5	-16	-15.5	-7.5	-16.5	-17	-8	-8.5	-8

Monte Carlo Simulator

Sample 6

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-9	-5.5	-9.5	-11.5	-10.5	-9.5	-13	-9	-12.5
Maximum Loss: 40 trades	-6.5	-4.5	-7	-10.5	-18.5	-11	-7.5	-10.5	-8.5	-10
Maximum Loss: 60 trades	-6.5	-3.5	-3.5	-7	-22.5	-8	-8	-12	-5	-14
Maximum Loss: 80 trades	-6.5	-1.5	3.5	-3.5	-29	-5.5	-6	-3.5	-3.5	-10.5
Maximum Loss: 100 trades	-2	3.5	8	-2.5	-23	-3.5	-4	-1	-0.5	-8
Maximum x trades	-10.5	-9	-7	-10.5	-29	-11	-9.5	-13	-9	-14

Monte Carlo Simulator

Sample 7

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-9	-10	-10	-7.5	-12	-8	-9.5	-12	-10.5	-9
Maximum Loss: 40 trades	-13.5	-8.5	-10	-9	-15.5	-16	-7.5	-13.5	-10	-12.5
Maximum Loss: 60 trades	-11	-3	-7	-6	-14	-7	-5.5	-19	-14.5	-10
Maximum Loss: 80 trades	-8.5	-1	-4.5	-7.5	-7	-4	-3.5	-13.5	-12.5	-11
Maximum Loss: 100 trades	-8.5	-0.5	-1.5	-4.5	4	-3	-0.5	-8	-10.5	-9.5
Maximum x trades	-13.5	-10	-10	-9	-15.5	-16	-9.5	-19	-14.5	-12.5

Monte Carlo Simulator

Sample 8

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-9.5	-9	-7	-9.5	-8	-10	-5.5	-9.5	-9
Maximum Loss: 40 trades	-9.5	-7	-10.5	-6.5	-14	-12	-16.5	-2.5	-8.5	-8.5
Maximum Loss: 60 trades	-9.5	-7.5	-9.5	-3	-12.5	-10	-17	2.5	-6.5	-10
Maximum Loss: 80 trades	-4	-7.5	-7	-2	-10	-9.5	-7.5	9.5	-4	-6.5
Maximum Loss: 100 trades	2	-7.5	1	6.5	-3.5	-3	-4.5	12.5	0	1
Maximum x trades	-10.5	-9.5	-10.5	-7	-14	-12	-17	-5.5	-9.5	-10

Monte Carlo Simulator

Sample 9

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-10	-11	-8	-7	-12	-9	-9.5	-10.5	-9
Maximum Loss: 40 trades	-12.5	-9.5	-10.5	-9	-8.5	-13	-8.5	-11	-11.5	-8
Maximum Loss: 60 trades	-14	-11.5	-8.5	-10	-8	-9.5	-3	-7.5	-11	-3.5
Maximum Loss: 80 trades	-17	-7.5	-6.5	-5.5	-3.5	-7	3	-10	-6	2
Maximum Loss: 100 trades	-19	-7.5	-2.5	-8.5	2.5	-7.5	6	-4.5	-3	2.5
Maximum x trades	-19	-11.5	-11	-10	-8.5	-13	-9	-11	-11.5	-9

Monte Carlo Simulator

Sample 10

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-12.5	-10	-9.5	-10	-9	-6.5	-9	-9	-13	-7
Maximum Loss: 40 trades	-9	-14.5	-14	-5.5	-9	-4	-9	-9	-11.5	-8.5
Maximum Loss: 60 trades	-6	-16.5	-11	0	-8.5	-3	-5.5	-10.5	-12.5	-5.5
Maximum Loss: 80 trades	-5	-14	-9.5	0	-7	3	-1.5	-8	-13	0.5
Maximum Loss: 100 trades	-1.5	-6	-6	2	-9.5	9	0.5	-5.5	-15	1.5
Maximum x trades	-12.5	-16.5	-14	-10	-9.5	-6.5	-9	-10.5	-15	-8.5

Monte Carlo Simulator

Sample 11

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-8	-11	-8	-10	-11	-11.5	-11.5	-15.5	-10.5
Maximum Loss: 40 trades	-15	-6	-9.5	-8.5	-9	-11.5	-14.5	-10.5	-13	-11
Maximum Loss: 60 trades	-14.5	-6.5	-6	-3.5	-7	-4.5	-14.5	-10.5	-14	-11
Maximum Loss: 80 trades	-19.5	-6.5	-1	-2.5	-5	-5.5	-18.5	-6.5	-17	-10
Maximum Loss: 100 trades	-15	-2	2.5	5	-6.5	-2.5	-17.5	0.5	-15	-6.5
Maximum x trades	-19.5	-8	-11	-8.5	-10	-11.5	-18.5	-11.5	-17	-11

Monte Carlo Simulator

Sample 13

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-10.5	-8	-8	-9	-9.5	-10.5	-9.5	-13	-10.5
Maximum Loss: 40 trades	-10.5	-12.5	-10	-10	-9	-12	-10	-9	-13.5	-11
Maximum Loss: 60 trades	-11	-11.5	-5.5	-10	-12	-18.5	-15	-8	-5.5	-8.5
Maximum Loss: 80 trades	-3.5	-10	-2	-4	-11	-20	-18	-9.5	-1.5	-6.5
Maximum Loss: 100 trades	0	-6.5	0	-3.5	-8.5	-17	-7.5	-10.5	-2	0
Maximum x trades	-11.5	-12.5	-10	-10	-12	-20	-18	-10.5	-13.5	-11

Monte Carlo Simulator

Sample 14

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-12	-9.5	-9	-10	-11.5	-9	-13	-17	-8.5
Maximum Loss: 40 trades	-10.5	-14	-3	-6	-5.5	-10.5	-13	-10	-23.5	-7.5
Maximum Loss: 60 trades	-7.5	-16.5	-3	-0.5	-1.5	-7	-11	-12	-19	-6.5
Maximum Loss: 80 trades	-5.5	-10.5	0.5	2.5	3.5	-9.5	-8	-9	-11.5	-1
Maximum Loss: 100 trades	-3.5	-5	2.5	2	7.5	-6	-10	-9	-7	2
Maximum x trades	-11.5	-16.5	-9.5	-9	-10	-11.5	-13	-13	-23.5	-8.5

Monte Carlo Simulator

Sample 15

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-9	-10	-9	-10.5	-9	-7	-14.5	-11.5	-12.5
Maximum Loss: 40 trades	-15.5	-10	-9.5	-11.5	-16	-10.5	-7.5	-15.5	-18	-14.5
Maximum Loss: 60 trades	-17.5	-8	-11	-8	-18	-10	-8	-8	-19.5	-6.5
Maximum Loss: 80 trades	-21	-8.5	-11.5	-1	-9.5	-8	-6.5	-10.5	-18	-5.5
Maximum Loss: 100 trades	-19	-4.5	-4.5	3	-9.5	-4.5	-5.5	-5	-17	-10
Maximum x trades	-21	-10	-11.5	-11.5	-18	-10.5	-8	-15.5	-19.5	-14.5

Monte Carlo Simulator

Sample 16

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-9	-14.5	-8	-11	-10.5	-10	-9.5	-9	-14	-11.5
Maximum Loss: 40 trades	-10	-13.5	-14.5	-10	-11.5	-9.5	-11.5	-13	-10.5	-11
Maximum Loss: 60 trades	-9	-14	-7.5	-4	-12	-12.5	-6	-15	-7	-10
Maximum Loss: 80 trades	-5.5	-14.5	-10	-1	-2.5	-13	-6	-21.5	-5	-9.5
Maximum Loss: 100 trades	-4	-15	-9	8	1.5	-14	-7	-18.5	0	-6.5
Maximum x trades	-10	-15	-14.5	-11	-12	-14	-11.5	-21.5	-14	-11.5

Monte Carlo Simulator

Sample 17

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7	-9	-9.5	-10.5	-9	-11.5	-8	-6.5	-10.5	-14
Maximum Loss: 40 trades	-7.5	-10.5	-14.5	-9	-9	-13	-11	-2.5	-12.5	-9.5
Maximum Loss: 60 trades	2	-11	-14	-5	-3.5	-10.5	-6.5	-2	-14.5	-7.5
Maximum Loss: 80 trades	5.5	-7	-12	-4	-1	-9.5	-7	2	-14	-7
Maximum Loss: 100 trades	7.5	-9.5	-8	-1.5	4	-6	-5	7	-9.5	-6.5
Maximum x trades	-7.5	-11	-14.5	-10.5	-9	-13	-11	-6.5	-14.5	-14

Monte Carlo Simulator

Sample 18

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7	-9	-10	-8	-11.5	-9	-12	-6.5	-10.5	-14.5
Maximum Loss: 40 trades	-5	-9.5	-11.5	-6	-16	-15.5	-12	-5	-8	-14
Maximum Loss: 60 trades	-5.5	-7	-13.5	-6	-23	-15.5	-11	-1	-8	-11.5
Maximum Loss: 80 trades	3	-7.5	-12.5	-5	-25	-16.5	-17	-1.5	-5	-11.5
Maximum Loss: 100 trades	3.5	-12	-12.5	-7.5	-25.5	-21.5	-16.5	7	-10	-10.5
Maximum x trades	-7	-12	-13.5	-8	-25.5	-21.5	-17	-6.5	-10.5	-14.5

Monte Carlo Simulator

Sample 19

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7.5	-10	-14.5	-10.5	-11.5	-9	-10	-12	-13	-6.5
Maximum Loss: 40 trades	-7.5	-12.5	-13.5	-17.5	-10.5	-13	-14.5	-9.5	-12	-4.5
Maximum Loss: 60 trades	-4.5	-17	-14	-17.5	-8.5	-12	-10	-5.5	-10.5	-2
Maximum Loss: 80 trades	4	-13.5	-10.5	-16.5	-7	-7	-4	-4.5	-15	1.5
Maximum Loss: 100 trades	8.5	-5	-9	-17	-7.5	-4	-2	-1.5	-14	3.5
Maximum x trades	-7.5	-17	-14.5	-17.5	-11.5	-13	-14.5	-12	-15	-6.5

Monte Carlo Simulator

Sample 20

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-14.5	-11.5	-8	-10.5	-12	-16.5	-9	-8	-13	-8
Maximum Loss: 40 trades	-16	-11	-12.5	-9	-12	-15.5	-8	-5.5	-14.5	-6
Maximum Loss: 60 trades	-21.5	-9	-7.5	-3.5	-9.5	-9	-8.5	-5	-16.5	-3.5
Maximum Loss: 80 trades	-23	-14.5	-4.5	3.5	-12	-10	-6.5	-3	-21	1
Maximum Loss: 100 trades	-22.5	-10.5	0.5	10.5	-9.5	-8.5	-5	4.5	-15	4.5
Maximum x trades	-23	-14.5	-12.5	-10.5	-12	-16.5	-9	-8	-21	-8

Monte Carlo Simulator

Sample 21

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-7.5	-8	-10	-12.5	-9	-12.5	-5.5	-9.5	-8
Maximum Loss: 40 trades	-16	-3.5	-9.5	-10	-11.5	-8.5	-12	-4.5	-11	-5
Maximum Loss: 60 trades	-13.5	-1.5	-4	-11	-13	-9	-15.5	-1.5	-10	-2
Maximum Loss: 80 trades	-13.5	7	0	-12.5	-11.5	-3.5	-15	3	-10.5	-2
Maximum Loss: 100 trades	-15.5	12.5	3	-12.5	-3	0.5	-12.5	10	-7.5	2.5
Maximum x trades	-16	-7.5	-9.5	-12.5	-13	-9	-15.5	-5.5	-11	-8

Monte Carlo Simulator

Sample 22

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8	-8	-11.5	-11	-12.5	-11.5	-8	-8	-11.5	-6.5
Maximum Loss: 40 trades	-5	-8.5	-13.5	-7.5	-13	-7.5	-13	-6	-10	-10
Maximum Loss: 60 trades	-4	-7.5	-16	-5	-13	-12	-15	0	-6.5	-6.5
Maximum Loss: 80 trades	2	-0.5	-14.5	-3.5	-14.5	-10	-9	3	-7	-7
Maximum Loss: 100 trades	6	4	-13.5	3	-16	-8	-8.5	5.5	-4	-6.5
Maximum x trades	-8	-8.5	-16	-11	-16	-12	-15	-8	-11.5	-10

Monte Carlo Simulator

Sample 23

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-7	-11	-9	-9.5	-9	-10.5	-9	-11.5	-9
Maximum Loss: 40 trades	-9.5	-7.5	-13	-10	-14.5	-8.5	-8.5	-6	-11	-11.5
Maximum Loss: 60 trades	-10.5	-5.5	-18.5	-8	-9	-9	-8.5	-4	-9	-6.5
Maximum Loss: 80 trades	-11	-3	-20.5	-6.5	-6	-5.5	-8	-2.5	-11.5	-3.5
Maximum Loss: 100 trades	-7.5	0	-17	0	-7.5	0	-3	0.5	-1.5	-3
Maximum x trades	-11	-7.5	-20.5	-10	-14.5	-9	-10.5	-9	-11.5	-11.5

Monte Carlo Simulator

Sample 24

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-9	-9.5	-8.5	-7	-8.5	-10.5	-12	-11.5	-11
Maximum Loss: 40 trades	-10.5	-10.5	-13.5	-9	-6.5	-9	-9.5	-7.5	-12	-11.5
Maximum Loss: 60 trades	-7.5	-12.5	-14.5	-10	-5.5	-7	-12.5	-4	-8	-9
Maximum Loss: 80 trades	-7	-14	-13.5	-11	-5	-5	-5.5	-3.5	-7.5	-13
Maximum Loss: 100 trades	-4.5	-15.5	-13	-9.5	-2	-1.5	3	-3	-5.5	-13.5
Maximum x trades	-10.5	-15.5	-14.5	-11	-7	-9	-12.5	-12	-12	-13.5

Monte Carlo Simulator

Sample 25

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-9	-15.5	-13	-11.5	-15	-8	-8	-15	-14	-12.5
Maximum Loss: 40 trades	-11.5	-21.5	-8	-10	-13	-3.5	-8.5	-10	-19.5	-9.5
Maximum Loss: 60 trades	-10	-23	-7.5	-8	-10.5	-1	-5.5	-10	-19.5	-6.5
Maximum Loss: 80 trades	-10.5	-32.5	-3	-6	-13.5	0	-4	-11.5	-18.5	-4
Maximum Loss: 100 trades	-8.5	-23.5	-5.5	0	-12.5	4.5	-2.5	-4.5	-13.5	-2.5
Maximum x trades	-11.5	-32.5	-13	-11.5	-15	-8	-8.5	-15	-19.5	-12.5

Monte Carlo Simulator

Sample 26

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-12.5	-7.5	-7	-15.5	-8	-9	-12	-11.5	-10.5
Maximum Loss: 40 trades	-7	-8.5	-3	-7.5	-16	-12.5	-13.5	-14.5	-8	-8
Maximum Loss: 60 trades	-4.5	-9	-0.5	-4.5	-14	-11	-11.5	-11.5	-4	-8
Maximum Loss: 80 trades	-3	-5.5	-0.5	-0.5	-9.5	-8.5	-8.5	-16	-4	-7
Maximum Loss: 100 trades	2	-0.5	0.5	1.5	-4.5	-12	-2	-15	4	-5
Maximum x trades	-10.5	-12.5	-7.5	-7.5	-16	-12.5	-13.5	-16	-11.5	-10.5

Monte Carlo Simulator

Sample 27

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-8	-14	-8	-7	-7	-15	-9	-9.5	-9.5
Maximum Loss: 40 trades	-14.5	-8.5	-13.5	-6	-10	-11.5	-23.5	-9.5	-11.5	-9
Maximum Loss: 60 trades	-12.5	-5.5	-15	-6.5	-6.5	-9.5	-25	-10	-6.5	-7
Maximum Loss: 80 trades	-11.5	-9.5	-13	-2	-4	-5	-24.5	-11.5	-4	-6
Maximum Loss: 100 trades	-10	-4	-9.5	4	2	1.5	-16	-5.5	-2	-6
Maximum x trades	-14.5	-9.5	-15	-8	-10	-11.5	-25	-11.5	-11.5	-9.5

Monte Carlo Simulator

Sample 28

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-13	-8	-12	-12	-7	-12	-11	-7	-8
Maximum Loss: 40 trades	-10.5	-13.5	-12	-15	-14.5	-3.5	-14.5	-14	-7	-8.5
Maximum Loss: 60 trades	-8.5	-12.5	-10	-14.5	-9	1	-17.5	-17	-5	-4.5
Maximum Loss: 80 trades	-11	-8	-1	-13	-6.5	3.5	-20	-9	-1	-4.5
Maximum Loss: 100 trades	-10.5	-6.5	3.5	-4.5	-5.5	10	-16	-7.5	3.5	-3.5
Maximum x trades	-13	-13.5	-12	-15	-14.5	-7	-20	-17	-7	-8.5

Monte Carlo Simulator

Sample 29

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-12	-11.5	-7	-14	-15	-6.5	-9	-9	-9	-10
Maximum Loss: 40 trades	-9.5	-13.5	-5	-9	-7.5	-8.5	-8	-9.5	-11	-4.5
Maximum Loss: 60 trades	-11	-13.5	-2.5	-6.5	-13	-1.5	-8	-5	-14	-3.5
Maximum Loss: 80 trades	-8	-16	0	-4	-11	-2	-9.5	-1.5	-11.5	0
Maximum Loss: 100 trades	-8.5	-14.5	1.5	0.5	-5.5	2	-8.5	-0.5	-0.5	2
Maximum x trades	-12	-16	-7	-14	-15	-8.5	-9.5	-9.5	-14	-10

Monte Carlo Simulator

Sample 30

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-7	-10.5	-8	-11.5	-16.5	-11	-8.5	-8	-12
Maximum Loss: 40 trades	-13	-9.5	-17.5	-14	-8	-12.5	-11.5	-5.5	-7.5	-8.5
Maximum Loss: 60 trades	-15	-7	-14	-13.5	-6.5	-12.5	-12	-2.5	-8	-2
Maximum Loss: 80 trades	-11.5	-4.5	-8	-12.5	-6.5	-11	-10	3	-5	0.5
Maximum Loss: 100 trades	-13	-3	-3	-13.5	2	-6.5	-6.5	10.5	-1	4
Maximum x trades	-15	-9.5	-17.5	-14	-11.5	-16.5	-12	-8.5	-8	-12

Monte Carlo Simulator

Sample 31

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-6.5	-11.5	-8.5	-8	-9	-10	-9	-13	-8	-11.5
Maximum Loss: 40 trades	-5.5	-13	-8	-9	-7.5	-5.5	-4.5	-12.5	-7.5	-13
Maximum Loss: 60 trades	-3.5	-10.5	-6.5	-7.5	-2	-1.5	-0.5	-15	0.5	-8
Maximum Loss: 80 trades	-1.5	-17	-4	-5.5	1	2.5	0.5	-14	3.5	-4.5
Maximum Loss: 100 trades	7	-10	-3	-3	-0.5	5	0	-11	2.5	-0.5
Maximum x trades	-6.5	-17	-8.5	-9	-9	-10	-9	-15	-8	-13

Monte Carlo Simulator

Sample 32

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10	-10.5	-9	-9	-10.5	-9.5	-9.5	-10.5	-7.5	-11.5
Maximum Loss: 40 trades	-13	-11	-10.5	-9	-10	-9	-8.5	-11.5	-10.5	-12.5
Maximum Loss: 60 trades	-12.5	-10.5	-11.5	-8.5	-9.5	-5	-5.5	-9	-12.5	-10.5
Maximum Loss: 80 trades	-8	-12	-5	-6.5	-12.5	-3	-0.5	-7.5	-14	-5.5
Maximum Loss: 100 trades	-1.5	-10.5	-4	-4	-10	-5	0	-1	-17	-6
Maximum x trades	-13	-12	-11.5	-9	-12.5	-9.5	-9.5	-11.5	-17	-12.5

Monte Carlo Simulator

Sample 33

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8	-10.5	-15	-9	-8.5	-9	-10.5	-16.5	-13.5	-9.5
Maximum Loss: 40 trades	-3	-9.5	-15.5	-7	-8	-8	-8	-13.5	-15	-13.5
Maximum Loss: 60 trades	1	-8	-14.5	-4	-14	-6.5	-3.5	-9.5	-17	-13
Maximum Loss: 80 trades	2.5	-5.5	-12	-4.5	-10.5	-5	-1	-10.5	-21.5	-9.5
Maximum Loss: 100 trades	7	-6	-11.5	2	-7	3	1	-10.5	-17.5	-2
Maximum x trades	-8	-10.5	-15.5	-9	-14	-9	-10.5	-16.5	-21.5	-13.5

Monte Carlo Simulator

Sample 34

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8	-8.5	-10.5	-11	-10	-9	-10	-9	-12	-9
Maximum Loss: 40 trades	-8	-7.5	-8.5	-13.5	-11	-7	-9.5	-5.5	-12.5	-9.5
Maximum Loss: 60 trades	-10	-6.5	-5	-10	-4.5	-6.5	-6.5	-4.5	-13	-9
Maximum Loss: 80 trades	-12	-3	-2	-7	-11	-5.5	2	-4	-12	-7
Maximum Loss: 100 trades	-11	0	0.5	-1	-6.5	-2	4.5	0.5	-11	-4.5
Maximum x trades	-12	-8.5	-10.5	-13.5	-11	-9	-10	-9	-13	-9.5

Monte Carlo Simulator

Sample 35

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-9	-10.5	-12.5	-14	-13	-9	-9	-10.5	-9
Maximum Loss: 40 trades	-12	-12	-9	-17	-9.5	-19.5	-7	-10.5	-13.5	-4
Maximum Loss: 60 trades	-12	-12.5	-9.5	-15.5	-9	-19	-1	-13	-12.5	-1
Maximum Loss: 80 trades	-12	-14.5	-7	-5	-8.5	-20	1	-13.5	-8	0.5
Maximum Loss: 100 trades	-6.5	-14.5	-7.5	-2	-10.5	-16	6	-10	-7.5	10
Maximum x trades	-13	-14.5	-10.5	-17	-14	-20	-9	-13.5	-13.5	-9

Monte Carlo Simulator

Sample 36

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-7.5	-10.5	-10.5	-12	-9	-8.5	-7	-8	-9
Maximum Loss: 40 trades	-12	-2.5	-8.5	-12.5	-12.5	-14	-11.5	-11	-6	-8
Maximum Loss: 60 trades	-12	-7.5	-10	-17.5	-15	-17	-11	-8.5	-5.5	-5
Maximum Loss: 80 trades	-11.5	-11.5	-10.5	-17	-17.5	-14	-10	-5.5	-1	-2.5
Maximum Loss: 100 trades	-7.5	-3.5	-10.5	-6	-13.5	-10	-11	4.5	2	-7
Maximum x trades	-12	-11.5	-10.5	-17.5	-17.5	-17	-11.5	-11	-8	-9

Monte Carlo Simulator

Sample 37

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-9	-11.5	-7	-10.5	-9	-12.5	-9.5	-6	-10	-8.5
Maximum Loss: 40 trades	-11	-8.5	-10	-7	-8	-17	-11.5	-8	-7.5	-11
Maximum Loss: 60 trades	-3	-12.5	-5.5	-2.5	-4	-14.5	-10.5	-1	-9.5	-7.5
Maximum Loss: 80 trades	-0.5	-10.5	-2.5	0	-0.5	-15	-2	-0.5	-4.5	-3
Maximum Loss: 100 trades	4.5	-9.5	-2	5.5	5	-15.5	7	0.5	-8.5	-3.5
Maximum x trades	-11	-12.5	-10	-10.5	-9	-17	-11.5	-8	-10	-11

Monte Carlo Simulator

Sample 38

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7	-7.5	-9.5	-14	-9	-13	-9	-10	-9.5	-9.5
Maximum Loss: 40 trades	-5	-4	-6	-18.5	-11	-13.5	-12.5	-9.5	-9	-10
Maximum Loss: 60 trades	-5.5	0	0	-21.5	-11.5	-10	-8	-9	-6	-12
Maximum Loss: 80 trades	-2	2.5	3.5	-18.5	-5.5	-6	0.5	-5	2.5	-6
Maximum Loss: 100 trades	2.5	4.5	3.5	-15.5	2	-7.5	4	-5	4.5	-8
Maximum x trades	-7	-7.5	-9.5	-21.5	-11.5	-13.5	-12.5	-10	-9.5	-12

Monte Carlo Simulator

Sample 39

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13.5	-9.5	-9.5	-8	-9	-9.5	-10.5	-9	-9.5	-9
Maximum Loss: 40 trades	-10	-8.5	-8	-8.5	-10.5	-11.5	-13	-15	-11	-11
Maximum Loss: 60 trades	-4.5	-9.5	-5	-8	-9.5	-9.5	-14.5	-12.5	-8.5	-14
Maximum Loss: 80 trades	-2.5	-5.5	-5	-10.5	-6	-6.5	-5.5	-8.5	-11.5	-17
Maximum Loss: 100 trades	1.5	-9.5	-4	-3	-10	-7	-5.5	-9	-10.5	-15
Maximum x trades	-13.5	-9.5	-9.5	-10.5	-10.5	-11.5	-14.5	-15	-11.5	-17

Monte Carlo Simulator

Sample 40

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7.5	-7.5	-9.5	-15	-12	-9	-10.5	-9	-11	-10.5
Maximum Loss: 40 trades	-8	-7.5	-10	-16.5	-8.5	-7	-7	-7	-12.5	-9
Maximum Loss: 60 trades	-1	-5	-7	-15.5	-8	-4.5	-5	-8.5	-11.5	-8
Maximum Loss: 80 trades	0.5	1.5	-3.5	-11	-4.5	-0.5	-11.5	-4.5	-5.5	-7
Maximum Loss: 100 trades	4	3	1.5	-9	-6	1	-8	-1	-5	-7
Maximum x trades	-8	-7.5	-10	-16.5	-12	-9	-11.5	-9	-12.5	-10.5

Monte Carlo Simulator

Sample 41

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-11.5	-14.5	-9.5	-10.5	-10.5	-9.5	-9.5	-9.5	-10
Maximum Loss: 40 trades	-7.5	-12	-12.5	-7.5	-15.5	-13.5	-10	-14	-8.5	-12
Maximum Loss: 60 trades	-2	-11	-14	-4	-20	-13.5	-6	-11	-9	-7.5
Maximum Loss: 80 trades	4	-10	-7	-4.5	-23	-14	-4	-14	-6.5	-5
Maximum Loss: 100 trades	7	-4	-9.5	-3	-13.5	-11	-1	-9.5	-1	-2.5
Maximum x trades	-13	-12	-14.5	-9.5	-23	-14	-10	-14	-9.5	-12

Monte Carlo Simulator

Sample 42

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-12	-9	-6	-8	-9	-11.5	-13	-9	-12
Maximum Loss: 40 trades	-8.5	-7	-9.5	-6.5	-11.5	-12	-13	-14	-8.5	-13
Maximum Loss: 60 trades	-11.5	-5	-8.5	-3	-14	-5.5	-10.5	-13	-2.5	-14
Maximum Loss: 80 trades	-8	-6	-7.5	-0.5	-18.5	-1.5	-7	-13	-1	-15.5
Maximum Loss: 100 trades	-2	-4	-9	2.5	-15	-6	-3.5	-11	-1.5	-13.5
Maximum x trades	-11.5	-12	-9.5	-6.5	-18.5	-12	-13	-14	-9	-15.5

Monte Carlo Simulator

Sample 43

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-12	-9	-10	-11	-7.5	-9	-12	-10.5	-8.5	-11.5
Maximum Loss: 40 trades	-11	-11	-5	-10.5	-7.5	-4.5	-12.5	-13	-9	-13
Maximum Loss: 60 trades	-14	-8	-3	-4	-5.5	-5	-12	-11.5	-11.5	-20
Maximum Loss: 80 trades	-8.5	-3	-1.5	2.5	-6	-0.5	-9.5	-9.5	-6	-20
Maximum Loss: 100 trades	-4	3	1	5	1	0.5	-3	-7	-6	-17.5
Maximum x trades	-14	-11	-10	-11	-7.5	-9	-12.5	-13	-11.5	-20

Monte Carlo Simulator

Sample 44

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-8	-14	-12	-9.5	-10.5	-9.5	-9	-9	-8	-12
Maximum Loss: 40 trades	-9	-19	-11	-9.5	-9.5	-12	-11.5	-11	-6	-13.5
Maximum Loss: 60 trades	-8	-16.5	-9	-7.5	-10	-11.5	-12.5	-11	-4	-9.5
Maximum Loss: 80 trades	-3	-18.5	-5.5	-4	-6.5	-8	-6.5	-9	3	-11.5
Maximum Loss: 100 trades	0.5	-22	-2	-3.5	-4.5	-2	-4	-10.5	8.5	-13.5
Maximum x trades	-9	-22	-12	-9.5	-10.5	-12	-12.5	-11	-8	-13.5

Monte Carlo Simulator

Sample 45

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-7.5	-8.5	-9	-11.5	-10.5	-9	-10.5	-11.5	-9	-11.5
Maximum Loss: 40 trades	-8.5	-10	-9.5	-13	-6	-12	-14.5	-8	-7	-12.5
Maximum Loss: 60 trades	-8	-10.5	-16	-10.5	-6	-5.5	-12	-7.5	-3.5	-13
Maximum Loss: 80 trades	-1.5	-3.5	-18.5	-14.5	-3.5	-2.5	-6.5	-6.5	-2.5	-14.5
Maximum Loss: 100 trades	0.5	1	-18	-10	0	0	-3.5	-3.5	-3	-9
Maximum x trades	-8.5	-10.5	-18.5	-14.5	-10.5	-12	-14.5	-11.5	-9	-14.5

Monte Carlo Simulator

Sample 46

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-11.5	-10	-9	-10.5	-9.5	-8	-10.5	-11.5	-9	-11.5
Maximum Loss: 40 trades	-3.5	-10	-6	-8.5	-11	-8	-8.5	-11	-10	-12
Maximum Loss: 60 trades	-1	-12	-3.5	-9	-10	-11.5	-6.5	-9.5	-8.5	-8.5
Maximum Loss: 80 trades	3.5	-9.5	2.5	-4.5	-6.5	-9.5	-9.5	-9.5	-5	-5
Maximum Loss: 100 trades	8.5	-10.5	5.5	0.5	-3.5	-7.5	-6	-10	-4	-1.5
Maximum x trades	-11.5	-12	-9	-10.5	-11	-11.5	-10.5	-11.5	-10	-12

Monte Carlo Simulator

Sample 47

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10	-9	-8	-13.5	-12	-9.5	-16.5	-9.5	-8	-11.5
Maximum Loss: 40 trades	-10.5	-10.5	-8.5	-7.5	-13.5	-8.5	-20	-9	-5	-12
Maximum Loss: 60 trades	-10.5	-6	-8	-5	-9	-2	-11	-9.5	-0.5	-10
Maximum Loss: 80 trades	-5	3.5	-7.5	-2	-11	-2	-10.5	-5.5	6.5	-11.5
Maximum Loss: 100 trades	-3	8.5	-0.5	-1	-10.5	2	-8.5	5	14	-9
Maximum x trades	-10.5	-10.5	-8.5	-13.5	-13.5	-9.5	-20	-9.5	-8	-12

Monte Carlo Simulator

Sample 48

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-13	-9	-14	-11.5	-10.5	-9.5	-11	-10.5	-8	-11
Maximum Loss: 40 trades	-9.5	-10	-9.5	-14	-14.5	-9	-15.5	-6	-13	-13
Maximum Loss: 60 trades	-3	-10	-8.5	-18.5	-9	-10	-18	0	-15.5	-16
Maximum Loss: 80 trades	0.5	-9.5	-2.5	-14.5	-3	-7.5	-13	3	-6	-15.5
Maximum Loss: 100 trades	6.5	-8	-1	-13	0.5	-5.5	-4	4	-4	-13.5
Maximum x trades	-13	-10	-14	-18.5	-14.5	-10	-18	-10.5	-15.5	-16

Monte Carlo Simulator

Sample 49

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10.5	-12	-9.5	-12	-10.5	-11.5	-9	-9	-5.5	-9
Maximum Loss: 40 trades	-14.5	-14	-13.5	-14	-15	-12.5	-8.5	-4	-5	-6
Maximum Loss: 60 trades	-11	-11.5	-11.5	-14.5	-7.5	-14.5	-6.5	0.5	-1	-6.5
Maximum Loss: 80 trades	-6.5	-11	-11	-17	-4.5	-16.5	-1.5	-0.5	1	-3
Maximum Loss: 100 trades	-3.5	-11.5	-10.5	-14	-2.5	-20	4	8	4	0
Maximum x trades	-14.5	-14	-13.5	-17	-15	-20	-9	-9	-5.5	-9

Monte Carlo Simulator

Sample 50

10 trials of 1000 trades

	A	B	C	D	E	F	G	H	I	J
Maximum Loss: 20 trades	-10	-10.5	-12.5	-12.5	-9	-11.5	-8.5	-9	-8	-7
Maximum Loss: 40 trades	-8	-17	-11	-12	-10.5	-15	-10.5	-8.5	-13.5	-4
Maximum Loss: 60 trades	-8	-14	-10	-9.5	-10.5	-8	-6	-10	-14	-5
Maximum Loss: 80 trades	-7.5	-6.5	-11	-5	-6	-5.5	-5.5	-7.5	-19.5	1
Maximum Loss: 100 trades	-8	-3	-11.5	-1.5	-6	1	-6	-4	-18.5	2
Maximum x trades	-10	-17	-12.5	-12.5	-10.5	-15	-10.5	-10	-19.5	-7